Anaerobic digestion: Sustainable Energy From food Waste

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Introduction

Food waste contributes signifcantly to environmental pollution and resource wastage. Our project tackles this problem by converting food waste into renewable energy using an anaerobic digester, enhanced with biochar to signifcantly boost methane production. This innovative solution not only reduces waste but also provides a sustainable energy source, addressing two critical environmental challenges in one system.

Constraints

Water Level
Waste Food Weight
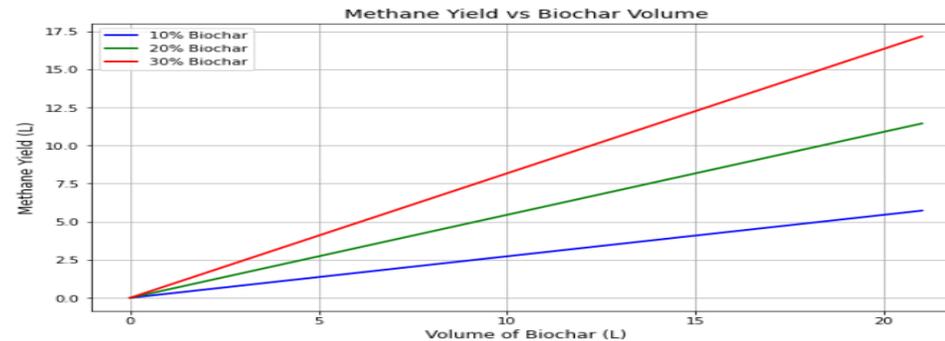pH Levels
Material Compatibility
Affordability

Specifications

Container Dimensions: 0.85 X 0. 67 X 0.5 (m)
Capacity: 300 L
Amount of Waste Food in Each Refill: 2 kg (at least)
Water Volume: 40% of Capacity = 120 L
Temperature Range: Mesophilic (30 – 40) C
Pressure : 1 atm
Gas Generation Volume: 50% of Capacity = 150 L
Storage Tank Volume: 0.125 $m3$

Prototype Design
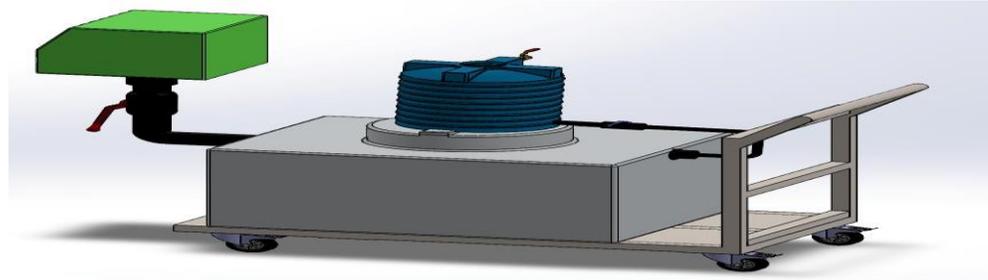
Biochar Usage

Methane Production Optimizing Model

Parameters

V = Total volume of the tank (300 liters)
Qw = The amount of water used (120 liters)
Qb = The amount of biochar (according the water level,the optimal amount = 2.1 to 6.3 liters)
Cf = The amount of carbon content in food waste (kg/liters)
Cb = The amount of carbon content in biochar (kg/liters)
$LRmax$ = Maximum Organic Loading Rate (value depends on the stability of the system) (approx. =10 kg/m³/cycle)
Cm = percentage of methane in the biogas produced (assumed to be 65%)
Desci

Decision variables

Pm = Methane production rate in (Liters/Cycle)
G = Total gasses produced (liters/ Cycle)
Q = amount of food waste to be used
$T0$ = Temp. of the digester (°C)

Maximize Pm

Subjected to:

The tank volume constraint: $Qw + Q + Qb \leq V$
Temp. constraint: $30 \leq T0 \leq 40$
Maximum Organic Loading Rate: $LRmax \times V \geq Q$
Production rate: $Pm \leq V$ 2
Amount of methane produced: $Pm \leq G \times Cm$ + Non-negativity constraint: $Pm, G, Q, T0 \geq 0$

Conclusion

Our project uses biochar-enhanced anaerobic digestion to convert food waste into renewable energy, boosting methane yields and offering a sustainable solution for waste management and clean energy production